

A New Subgenus and Species of Coral-Inhabiting Barnacle from the Gulf of California

by

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(Plate 17, 2 Textfigures)

The balanomorph barnacle genera Creusia Leach, 1817, and Pyrgoma Leach, 1817, which occur embedded in the coralla of anthozoan and milleporine corals, have traditionally been considered derivatives of Balanus Da Costa, 1778, through loss and concrescence of various compartmental plates of the shell. The gradational aspect of the series Balanus (shell with six compartmental plates)-Creusia (shell with four compartmental plates)-Pyrgoma (shell formed of a single plate) has been recognized for some time. Darwin (1854, p. 375) was reluctant to consider Creusia apart from Pyrgoma stating that "had not this genus already been adopted by several authors, I should not, I think, myself have formed it. . .". Elsewhere he (Darwin, loc. cit., p. 359) observed that "the subgenus Creusia is closely, perhaps too closely, allied to Pyrgoma". Species variously referred to Creusia and Pyrgoma are known which are characterized by an intermediate stage in the concrescence of the compartmental plates and appear to form "connecting links" between typical Creusia and typical Pyrgoma. Recently, on the basis of these intermediate forms, Brooks and Ross (1960, p. 361) concluded that Darwin's uncertainty was justified and synonymized Creusia with Pyrgoma.

Withers (1926, 1929, 1935) has discussed the phylogeny of these coral-inhabiting barnacles in respect to their fossil record and concluded that "Pyrgoma is, no doubt, a derivative from Creusia, but certain Miocene forms of similar coral-living barnacles have six compartments like Balanus (Withers, 1929, p. 560), so that in this little group alone there is a transition from forms having six compartments to a single shell" (Withers, 1935, p. 38). Evidence

of the transition from forms having six compartmental plates to those having four, however, has been lacking. Apparently the Creusia condition was derived through the loss of the carinolaterals of the Balanus ancestor (Withers, 1935, p. 38). However, the six-plated Miocene species, Balanus duvergieri (de Alesandri), discussed by Withers (1929, p. 560) is a Balanus in all respects but habitat and no form is known that exhibits any indication of reduction of the carinolaterals toward the Creusia condition. Withers (1935, p. 38) presents Acasta sporillus Darwin as an example of an intermediate form in which "the carinolaterals do not reach to the basis and appear to be on their way to being crowded out". However, the loss of carinolaterals in A. sporillus need not necessarily have a direct relationship to the development of Creusia from Balanus.

The discovery of a new coral-inhabiting barnacle in the Gulf of California lends added strength to the hypothesis of the derivation of the Creusia condition from a Balanus ancestor. Both fossil and living specimens of this barnacle have been found embedded in coralla of the hermatypic stony coral Porites californica Verrill from several localities throughout the Gulf (textfigure 2). This barnacle is creusoid in all respects (e. g., the cup-shaped to sub-cylindric basis, the exterior ornamentation of the parieties, the extension of the sheath nearly to the basal margin and the continuous lower edge of the sheath, the plate-like nature of the internal ribs or longitudinal septa, and the creusoid nature of the opercular valves) except that it has a shell composed of six plates as in the genus Balanus. For this reason a new supraspecific taxon, here considered as a subgenus of Balanus, is erected for this species.

Cirripedia

THORACICA DARWIN

Balanomorpha PILSBRY

BALANIDAE GRAY

Balaninac GRAY

Balanus DA COSTA*Hexacreusia* ZULLO, subgen. nov.

DIAGNOSIS

Compartmental plates six; shell depressed; parieties solid; radii broad, solid, with thick, septate edges; sheath extending nearly to basal margin; lower edge of sheath free, continuous; basis calcareous, solid, cup-shaped to sub-cylindric; opercular plates as in *Creusia*; appendages and mouth parts balanoid.

TYPE SPECIES

Balanus (*Hexacreusia*) *durhami* Zullo, spec. nov.

ADDITIONAL SPECIES

Possibly *Balanus duvergieri* (de Alessandri).

GEOLOGIC RANGE

? Early Miocene (*Balanus duvergieri*); late Pliocene to Recent (*Balanus durhami*).

HABITAT

Living in the coenosteum of the coral *Porites*.

REMARKS

This new subgenus is created to include a species which in every respect, excepting the number of compartmental plates in the shell wall, could be assigned to the genus *Creusia*. At least some forms included within *Creusia* appear to have developed from an hexacreusoid ancestry. The creusoid shell morphology either resulted through the loss of the carinolaterals or through their concrescence with the laterals or, possibly, the carina. The available evidence, although negative, favors the loss of the carinolaterals, as there have been no records, either extant or fossil, of intermediate stages of fusion between the six- and four-plate condition.

The conclusions reached by Brooks and

Ross (1960) regarding the classificatory significance of the presence of separate compartmental plates or sutures in the shell wall as the distinguishing feature in the separation of *Creusia* from *Pyrgoma* could also be extended to *Hexacreusia*. However, where they regard the presence of intermediate stages in the development of the concrescence of the shell as indicating that the genera *Pyrgoma* and *Creusia* should not be separated, I would interpret these intermediate stages in development as indicating a phylogenetic relationship between the two: *Creusia* with the shell of four, unfused compartmental plates giving rise to *Pyrgoma* with a shell composed of fused plates. Any closely-linked, phylogenetic series should be expected to include forms of intermediate nature, but these forms do not govern the validity of recognizing and delimiting categories (in this case the end members) within the series.

This latter concept is exemplified by *Hexacreusia*. In synonymizing *Creusia* with *Pyrgoma*, Brooks and Ross (1960, p. 361) modified the diagnosis of *Pyrgoma* "to include all the obligate, epizoic, tetramerous barnacles with their basis invaginated in the corallum of live corals". Application of the criteria used by Brooks and Ross (loc. cit., pp. 359-362) to the relationship of *Pyrgoma* to *Balanus* in view of the new six-plate, creusoid species here described would result in the suppression of *Pyrgoma* inasmuch as these genera differ only by the number of compartmental plates in the shell wall.

Presently, *Hexacreusia* is definitely represented only by the type species. However, the specimens from the Miocene of Bordeaux, which had been assigned by Withers (1929, p. 560) to *Balanus* (*Balanus*) *duvergieri* (de Alessandri) are possibly referable to *Hexacreusia*. Withers' assignment of this species to the subgenus *Balanus* was based on the irregularly porous nature of the parieties of some of the specimens. The parieties of the remaining specimens were noted as being solid. These pores are probably homologous with those in some individuals of *Creusia* described by Darwin (1854, p. 377) and interpreted to represent spaces left by the incomplete filling of the internal rib interspaces, and are not, therefore, homologous with the parietal tubes in the subgenus *Balanus*. Withers (1929, pp. 565-566) considered *Balanus duvergieri* as representing an early stage in the development of *Creusia*.

Balanus (Hexacreusia) durhami ZULLO, spec. nov.

(Textfigure 1: Plate 17)

DIMENSIONS

of Holotype, University of California Museum of Paleontology (hereafter referred to by the abbreviation UCMP) No. 34'689, height (excluding elongate basis) 0.7 mm., carinorostral diameter of orifice 0.9 mm., carinorostral diameter of base 3.0 mm. The height of the shell including the elongate basis may be as much as 4.5 mm.

DESCRIPTION

Shell small, depressed conic; orifice small, subtrigonal to diamond-shaped, not toothed; parieties solid; surface of parieties pink in color, somewhat regularly ribbed; ribs project from base of compartmental plates, giving stellate appearance to shell; radii broad, glossy, lighter pink in color than parieties or white, vertically striate; summits of radii horizontal; sutural edges of radii thick, with primary and secondary denticulae; alae thin; sheath long, extending nearly to basal margin, lower edge free, continuous; interior of parieties ribbed; ribs plate-like in appearance, continuing underneath edge of sheath; basis cup-shaped or conical, up to three and one-half times as long as height of compartmental plates, solid, radially ribbed; ribs and alternating furrows of basis correspond to ribs and furrows of parieties; ribs on interior of basis finely beaded.

Scutum white with pink-tinged, beaked apex; tergal part reflexed at right angles to rest of plate; exterior ornamented by thin, closely-spaced growth lines; irregular, longitudinal furrow divides exterior of plate in position of (adductor ?) ridge on interior; basal margin sinuous, longer than tergal margin; occludent margin straight, toothed; articular ridge high, almost as long as tergal margin; articular furrow narrow, shallow; thin ridge (adductor ?) extends from middle of scutum to basal margin and continues along basal margin to basioccludent angle; shelf continuous with occludent margin and occludent side of the articular ridge projects out over half the interior of the scutum leaving a deep pocket beneath it; free (basal) edge of shelf sinuous; shelf widest in apical part, narrowing towards and terminating in basioccludent angle; pit for depressor muscle small, deep, situated on edge of basal margin at point of reflection of tergal part of scutum; "rostral tooth" suggested by intersection of occludent shelf and basal margin at basioccludent angle.

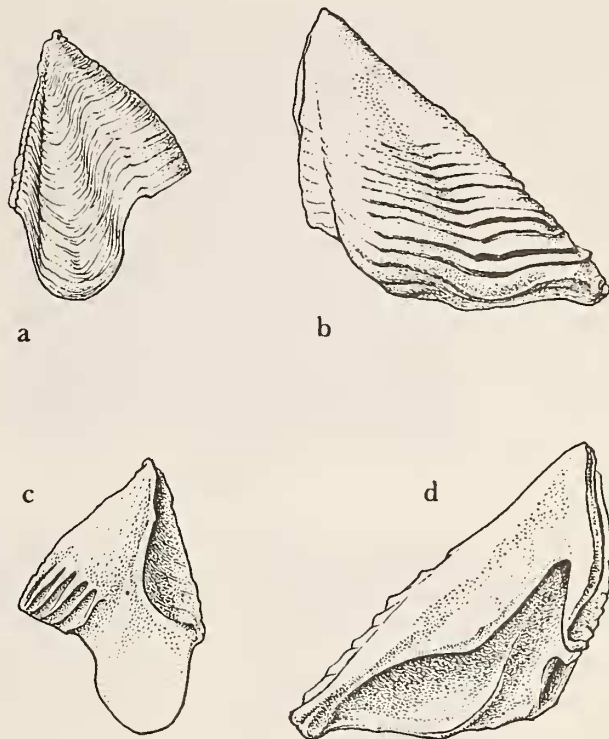


Figure 1: Opercular plates of *Balanus (Hexacreusia) durhami* ZULLO, spec. nov., x 25. a - exterior of tergum, paratype UCMP no. 34691; b - exterior of scutum, paratype UCMP no. 34690; c - interior of tergum, paratype UCMP no. 34691; d - interior of scutum, paratype UCMP no. 34690.

Tergum white in color, tinged pink at apex; carinal part of tergum curving inwardly; articular ridge low, thin; articular furrow broad, shallow; depressor muscle crests well developed; scutal and carinal margins straight; spur broad, one-half width of basal margin, situated close to, but differentiated from, the basiscutal angle; spur long, length approximating width; end of spur broadly rounded; spur furrow not sharply differentiated.

Labrum deeply notched with three prominent, blunt, triangular teeth and one or two smaller teeth on each side.

Palpi with numerous, closely clustered, short, curved, pectinate spines arranged in two parallel rows along superior margin; a few long spines situated on inner margin.

Mandibles with five teeth including inferior angle; first, second, and third teeth large, distinct; second and third teeth bifid; fourth and fifth teeth smaller than preceding; fourth tooth bifid; fifth tooth trifid; distance between first and second tooth one and one-half times greater than distance between second and third tooth;

first, second, and third teeth occupying nearly three-fourths entire cutting-edge; inferior margin of mandible and posterior surface of mandible hirsute.

Inner maxillae with irregular, nearly straight cutting edge; rudimentary notch located below uppermost two large spines; two small spines situated in notch; five large spines with a few smaller spines situated below notch; lowermost two of the large spines as large as the large spines above notch; large spines followed by approximately five small spines; edge below inferior angle bearing several small spines.

Outer maxillae of two lobes (as figured by Hoek, 1913, pl. 27, fig. 8; and Nilsson-Cantell, 1921, textfig. 79e), bearing numerous pectinate bristles.

Rami of Cirrus I unequal, densely setose; outer ramus about one-third again as long as inner ramus, curved posteriorly in opposing direction from all other rami.

Rami of Cirrus II similar in structure to those of Cirrus I, densely setose, unequal, with outer ramus being longer.

Cirrus III more similar in structure to Cirri I and II than to Cirri IV to VI; rami of Cirrus III not as densely setose as those of Cirri I and II, subequal with outer ramus longer; articles 1 through 6 on outer ramus (counting distally from pedicel) bearing teeth on posterior and upper margins.

Cirri IV through VI with subequal rami, inner rami slightly longer than outer rami; intermediate segments of rami bearing one to three pairs of setae on posterior margins.

The number of articles on the individual cirri (paratype California Academy of Sciences No. 12'372) are as follows:

Cirrus:	I	II	III	IV	V	VI
Outer Ramus:	10	7	7	10	13	13
Inner Ramus:	6	5	6	10	14	14

HOLOTYPE

UCMP No. 34'689, from UCMP locality A-3652. Paratypes: UCMP Nos. 34'690, 34'691, from UCMP locality A-3640; UCMP No. 34'692, from UCMP locality A-3642; California Academy of Sciences No. 12'372, from CAS locality 36'745.

OCCURRENCE (Textfigure 2)

Late Pliocene, Gulf of California, UCMP localities A-3519, A-3534; Pleistocene, Gulf of California, UCMP localities A-3525, A-3547, A-3582, A-3584, A-3596; Recent, Gulf of California, UCMP localities A-3640, A-3642, A-3646, A-3652, A-3653, A-3654, A-3663, California Academy of Sciences locality 36'745.

RANGE

Late Pliocene to Recent, Gulf of California.

REMARKS

Balanus durhami differs from all known species of *Balanus* and *Creusia* in the possession of an occludent shelf on the interior of the scutum (textfigure 1d). The tergum somewhat resembles that of *Creusia spinulosa* var. *breviterga* Hiro (1938, p. 397) but can be distinguished by its longer, narrower spur (textfigures 1a, 1c). The opercular plates of *B. durhami* do not appear to be as variable in form as those described by Hiro (1938).

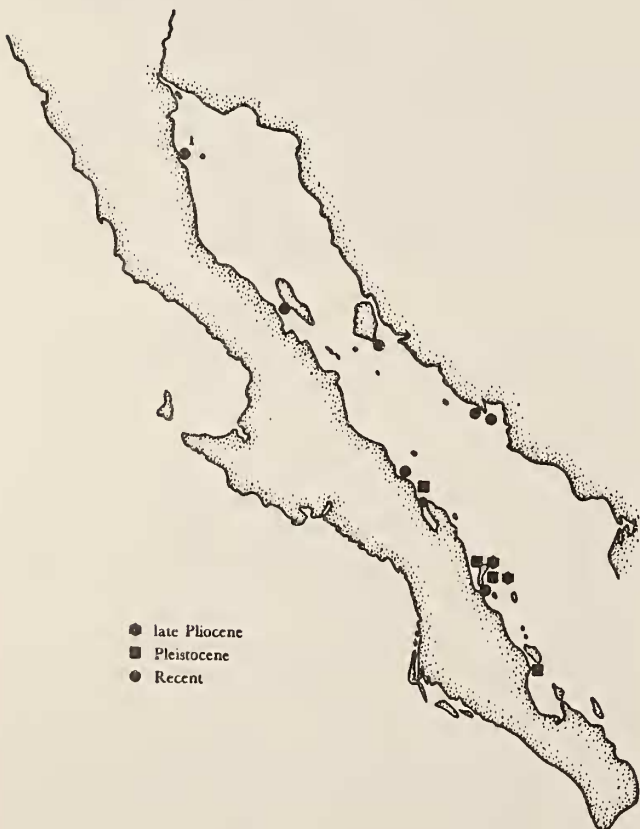


Figure 2: Late Cenozoic distribution of *Balanus* (*Hexacreusia*) *durhami* ZULLO, spec. nov. embedded in *Porites californica* VERRILL in the Gulf of California.

1: northernmost occurrence of *Porites californica* (CAS locality 36'745)



Figure 1

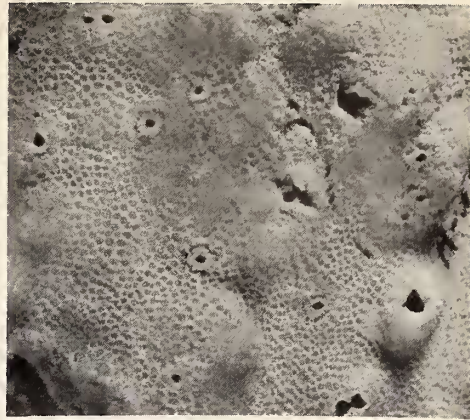


Figure 2



Figure 3



Figure 4



Figure 5

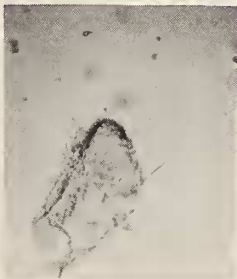


Figure 6



Figure 7



Figure 8

Balanus (Hexacreusia) durhami ZULLO, subgen. et spec. nov.

Figure 1: Holotype UCMP no. 34689, x 2.5 (center specimen); Figure 2: Paratype UCMP no. 34692 and associated individuals embedded in the coenosteum of *Porites californica* VERRILL from UCMP locality A-3642, x 1. Figures 3 to 8: Mouth parts and appendages of paratype CAS no. 12372, x 70. Figure 3: Labrum (teeth partially obscured); Figure 4: Right mandible; Figure 5: Right inner maxilla; Figure 6: Right outer maxilla; Figure 7: Right labial palp; Figure 8: Right Cirrus III (outer ramus above).